

## **Remarks**

### **Summary of Amendments**

The article cited but not properly disclosed by the applicant is now included and disclosed as per Objection #1.

The independent claims 1 and 13 have been amended to include a specification of a transparent means of positioning the surfaces and claims 2,5,6,14 and 16 are canceled in view of the coverage afforded by the remaining claims.

Please note: Since Claims 1 and 13 are relatively long, the applicant has amended and limited them by the insertion of the text from claim 2 and 14 (respectively) into them, rather than inserting very large amounts of text into Claims 2 and 14. Claim 2 and 14 are now canceled. Thus the effect is that Claim 1 and Claim 13 are now equivalent to claims 2 and 14 from the original application, and the effect is that the original Claim 1 and 13 have been canceled, although in this action Claim 1 and Claim 13 are amended.

As per Objection #2 in the Office Action, the language of Claim 1 and 13 have been modified to clarify the ability to handle electromagnetic radiation of any frequency.

As per Objection #3, Claims 7-9 have been amended to mention only a

single Claim, placing them in proper dependent form. Claims 18-20 are amended to obtain the same effect.

As per Objection #4, in Claim 3 the phrase "can be performed" has been amended to a "wherein" clause, clarifying the fact that the text following the word "wherein" is a limitation of Claim 3.

As per Objection #5, in Claim 10 and 11 the phrase "may be constructed" has been amended to a "so that" clause, clarifying that the text following the "so that" is not a limitation of those claims.

As per Objection #6, the phrase in claim 3 "the outer side of the surface" has been completely rewritten in a way that is hopefully much clearer.

As per Objection #7, the misspelling of the word "transparent" has been corrected in Claim 3.

Claim 20 has been amended, changing word "whereby" to "enabling" and fixing a missing word.

### **Review of Objections**

Objections #1 points out a failure to disclose a source properly.

Objections #2 through #7 point out formal problems in claim language or structure, each of which has been addressed.

Object #8 is general information rather than a specific rejection.

Objection #9 by the Examiner rejects claims 1,5,13, and 16 in the original application under 35 U.S.C. 102(e) as anticipated by Li US 6,634,759.

Claims 5 and 16 have been canceled in view of coverage afforded by other claims. Claims 1 and 13 have been amended by reciting the element of a transparent medium (originally claimed in the now canceled) claim 2.

In objection #10, the Examiner rejects claim 2 as obvious (see below), but claim 2 was not objected to under 35 U.S.C. 102(e), so claims 1 and 13 are now proper as per 102(e).

Objection #11 is general information rather than a specific rejection.

Objection #12 rejects claims 2, 3, 4, 6, 14, 15, and 17 as obvious in light of the combination of Li US 6,634,759 and Ortabasi US 6,252,155. As claim 1 and claim 13 have been amended so that it is essentially the same as the original claim 2, this objection must be overcome. The patentability of all dependent claims as amended will follow from their being narrowings of independent claims 1 and 13 as amended, in addition to novel features they recite.

Objection #13 rejects Claim 10 under 35 U.S.C. 103(a) as being unpatentable over Li in view of Hough et al US 6,123,436.

Objection #14 rejects Claim 11 as being unpatentable over Li in view of Ortabasi and further in view of Hough et al.

Object #15 rejects Claim 12 as unpatentable over Wolter US 2,759,106 in view of Hough.

Objection #16 raises an interesting point. Although Hunter US 4,357,075 is not directly cited against the patentability of these amended claims, the Examiner's citation, comments, and a confusing point in Hunter lead the applicant to also discuss this patent.

### **Response to Objections**

Objections #2-7 are answered by modifications to the language and structure of the relevant claims.

The article cited but not properly disclosed by the applicant is now included and disclosed as per Objection #1.

#### **Objections #2 - #7 addressed by changes in claim language**

As per Objection #2 in the Office Action, the term "optical apparatus for magnification" has been changed to "apparatus for magnification" in Claim 1 and 13 to clarify the ability to handle electromagnetic radiation of any frequency, so that Claim 12 is now a limiting dependent claim of Claim 1. Claim 12 has also been modified to contain a "wherein" clause, making the limitation more clear.

As per Objection #3, Claims 7-9 have been amended to mention only a single Claim by replacing a claim reference with the relevant text, placing them in proper dependent form. Claims 18-20 are similarly amended to obtain the same effect.

As per Objection #4, in Claim 3 the phrase "can be performed" has been amended to a "wherein" clause, clarifying the fact that the text following the word "wherein" is a limitation of Claim 3.

As per Objection #5, in Claim 10 and 11 the phrase "may be constructed" has been amended to a "so that" clause, clarifying that the text following the "so that" is not a limitation of those claims.

As per Objection #6, the phrase in claim 3 "the outer side of the surface" has been completely rewritten in a way that is hopefully much clearer. It now reads (in clean-text form, see the claim above for the amendment from the original):

wherein the surfaces are reflecting because the inner transparent solid material that is proximal to the optical axes has a higher index of refraction than the surrounding material that is distal from the optical axes, wherein a single solid object magnifies with substantially no losses due to reflection from metal or losses from internal air-material interfaces.

As per Objection #7, the misspelling of the word "transparent" has been corrected in Claim 3.

Additionally, spelling errors in claim 9 have been corrected.

### **Objection #9 is accepted**

Objection #9 rejected claims 1, 5, 13, and 16 under 35 U.S.C. 102(3) as being anticipated by Li.

Claims 1 and 13 have been amended to become effectively the original claims 2 and 14, which were not objected to in Objection #9, and claims 5 and 16 are canceled.

Thus each claim in this objection is either canceled or transformed into a different claim not objected to in Objection #9.

### **Objection #10 is accepted**

Objection #10 similarly rejected claims 1, 5, 13, and 16 under 35 U.S.C. 102(b) as being anticipated by Wolter.

Claims 1 and 13 have been amended to become effectively the original claims 2 and 14, which were not objected to in Objection #10, and claims 5 and 16 are canceled.

Thus each claim in this objection is either canceled or transformed into a different claim not objected to in Objection #10.

### **Overcoming Objection #12**

Objection #12 is a critical objection to the matter of the remaining amended claims. The next three pages discuss how this objection is overcome.

### **Brief Review of the Invention**

In preparation of the following discussion of the serious objection #12, it is worth briefly reviewing the main point of this invention. From the abstract:

It is taught that two reflective parabolic or paraboloidal surfaces of **different** scales whose axes point in opposite directions but which share a common focal point can be used as an **image forming** telescope. If only a portion of a parabolic or paraboloidal **sliced along the optical axis** is used as the surfaces, then they can be configured so that light rays strike the surfaces at such angles as to be **totally internally reflected**. Thus a **solid prism** can be constructed that serves as telescopic or non-imaging collector of light **with no loss of energy** due to internal reflection or refraction. Since this system does not depend on an optically precise entry surface, it may be useful in fiber optic and solar power applications.

The applicant has placed in boldface the issues in the abstract must relevant to the claims that have not been canceled.

### **Objection #10 and Objection #16 of the Office Action Raise Points About Prior Art**

Although the claims rejected to under in Objection #10 have been canceled or significantly amended, the Examiner raises an interesting point about Wolter US 2,759,106 that should be clarified. The Examiner additionally notes that Hunter US 4,357,075 teaches an apparatus comprising paraboloidal surfaces with their axes substantially colinear and with a shared focal point as shown in Figure 2.

The examiner points out that Wolter recites "an optical apparatus for magnification comprising an objective reflecting surface in the shape of a truncated half paraboloid....." However, Wolter teaches a truncated paraboloid, not a "half paraboloid formed by revolving a parabola for only 180 degrees of a full revolution", as specified in Claim 1 of this

application. The difference is that a truncated paraboloid is truncated perpendicular to the optical axis of the paraboloid, whereas the applicant is using the term "half paraboloid", as the drawing and specification makes clear, to mean a truncation parallel to (in fact coincident with) the optical axis. This is further clarified and emphasized by the language in Claim 1 of "revolving a parabola about its axis for only 180 degrees." Li teaches such a split along the optical axis for ellipsoidal shapes, but Hunter, Wolter, and Hough US 6,1234,436 do not.

It is important to note that Hunter, Wolter, and Hough are similar in that they do not teach a split along the optical axis using surfaces of revolution of just 180 degrees. Hunter, in particular, has drawings which show elements on only one side of the optical axis, and therefore superficially appears to be similar to the invention of the applicant. However, a close reading shows that in fact Hunter, Wolter and Hough all imagine complete 360 degree surfaces of revolution. They therefore only tangentially bear upon the main insight of the present invention as expressed in Claim 1 as amended, that it is possible to build an imaging apparatus from a single piece of transparent material using the configuration of internal reflectors split along the optical axis as claimed in the (amended) Claim 1.

Hough is later mentioned with respect to baffles in Objection #13 and #14, but it is important to note that even in light of Hunter, Wolter, and Hough all taken together there is nothing to suggest the particular 180-degree revolution of surfaces of the amended Claim 1.

**Objection #12 is overcome**



## **Li teaches away from high magnification, internal reflection**

As the Examiner correctly points out, Li is relevant prior art (of which the applicant was previously unaware) that teaches two surfaces of revolution of approximately 180 degrees, of general shape and general configuration of which a special case is the specific paraboloidal element of amended Claim 1 of this application. Li is primarily about image projection from a source at hand, rather than energy collection from a distant source. Li is particularly seeking to avoid magnification different than 1-to-1, see lines 23-25 column 2, lines 55-65 column 2, lines 61-66 column 3, lines 16-23 of column 4, and line 64 of column 5, and teaches away from high magnification. In particular lines 16 through 23 of column 4 teach toward using reflectors of the same size:

“The first reflector and the second reflector have substantially the **same size** and shape and maybe oriented optically about [sic] symmetrically with respect to each other so that each ray of radiation reflected by a surface portion of the first reflector is reflected by a corresponding surface portion of the second reflector toward the target to achieve **unit magnification**.”

(The applicant has added the bolded emphasis. In the opinion of the applicant, Li is using the term “unit magnification” to mean the lack of aberration due to varying magnification across the image, rather than the overall magnification of the system, typically expressed as the ratio of the objective focal length to the ocular focal length. However, in the example of Li, the reflectors always seem to have the same size and focal length, so Li is also teaching “unit magnification” in the traditional sense of that term.)

Note that Claim 1 uses the language: “ocular reflecting surface of same

shape but of **different size**" (Emphasis added.) Because Li is concerned with collection of energy from a small artificial source that is very close to the reflectors and emphasizes unit magnification (that is, no change in the brightness or size of the virtual image constructed by the system) Li teaches away from the magnification which is the purpose of this invention. Li does not teach toward telescoping or collection of energy from distant sources, for the same reason: that patent is concerned with very close-by, hot, artificial sources. The problem of heat dissipation would in the Li application would preclude (from amended Claim 1) "a solid material that is substantially transparent to some electromagnetic radiation and fills the inner space between the objective reflecting surface and the ocular reflecting surface", because it would melt.

### **Ortabasi is non-imaging**

Ortabasi teaches the use of total internal reflection from within a relatively dense optical medium. This is also taught by the references cited by that applicant, such as Richard US 5,669,186 and Iizuka US 6,049,429 and others.

Ortabasi describes solar energy collection using strictly non-imaging optics. That is, although the technique of Ortobasi provides concentration of energy, it does not magnify, or preserve, an image. There is nothing in Ortobasi that suggests combination with Li or any image-forming technology. An image-forming system such as the present invention in the amended Claim 1 has the particular advantage that the sun, being a disc of known arc in the sky, can be produce an image of known and predictable angular dispersion of the rays that come out of the apparatus. This advantage allows the dispersion angle of the collected rays to be matched to the target, whether the target is

a light guide, which must have a limited acceptance angle, or a solar cell, whose efficiency depends to some extent on the angle of incident of the rays that it collects. It is in fact known that non-imaging optics, such as in Ortabasi, can theoretically provide a higher concentration than imaging optics, such as in the present invention. This fact does not, however, cancel all unexpected advantage of controlling the dispersion angle of the solar rays offered by the invention of the amended Claim 1.

As the Examiner points out in paragraph 4 of Objection #12 of the office action, Ortabasi does indeed teach "the means of positioning the two surfaces is a solid material that is transparent and fills the inner space between the two surfaces...." (as do other image-forming patents cited as prior art by the applicant) but does not suggest the the arrangement of using a surface of revolution revolved 180 degrees and pointing in opposite directions. In fact, the cells of Ortabasi are polygonal and not of semicircular (or circular) shape, nor does Ortabasi use surfaces of revolution (though it mentions them as prior art.) For example, the language of lines 44-63, column 2 of Ortabasi and lines 29-36, column 4 of Ortabasi teach 2-dimensional curved surfaces arranged in a trapezoid to construct the so-called "(2-D/3-D) concentrator cusp unit". This is quite different than a 3-D surface of revolution which enables true image forming, and Ortabasi teaches away from that. Moreover, Ortabasi mentions Gradient Index (or GRIN) materials and bi-axial lenses quite frequently, further teaching away from the relatively simple invention of the amended Claim 1, which does not require any such GRIN material.

**Summary of unobviousness of amended Claim 1 and amended Claim 13**

Even fully aware of Li and Ortabasi and all other known prior art, Claim 1 as amended is not suggested by any combination of prior art because:

- Li teaches reflectors of “same size” and “unit magnification”, but Claim 1 specifically says “different size”,
- Li assumes that the sources are always very close to the “ellipsoidal” reflectors, whereas the “paraboloidal” shape of Claim 1 works only if the source is very distant,
- Li does not suggest the possibility of internal reflection or a transparent filling material as per (amended) Claim 1.
- Ortabasi teaches away from imaging optics and teaches concentration rather than image magnification completely,
- Ortabasi teaches away from 3D surfaces of revolution as recited in Claim 1: “...truncated half-paraboloid formed by revolving...”, and
- Ortabasi does not suggest combination with Li or any configuration of two half-revolved surfaces split along the optical axis.

### **Claim 3 clarified and produces unexpected result**

The amended Claim 3 is a narrowing dependent claim of the amended Claim 1, and therefore patentable if Claim 1 is. Moreover, Claim 3 represents a surprising and unexpected result, namely that it is possible to magnify an image with zero light loss with a specially shaped prism under some circumstances.

However, Objection #12 rejects Claim 3 and Claim 15 on the basis that Ortabasi teaches the use of a transparent solid material that has a higher index of refraction than the surrounding side of the surface. (Note the applicant has attempted to clarify this language as objected to in Objection #6, by amending to the language: “because the inner

transparent solid material that is proximal to the optical axes has a higher index of refraction than the surrounding material that is distal from the optical axes.")

However, Claim 3 as amended is even more unobvious than Claim 1, because it produces an unexpected result: the ability to produce a magnified image with no energy losses whatsoever based on the phenomenon of total internal reflection. The original language of Claim 3 has been modified to read "~~whereby magnification can be performed~~ by wherein a single solid object magnifies with substantially no losses due to reflection from metal or losses from internal air-material interfaces." This change addresses the Examiner's point that the original language is unclear, and also limits the amended Claim 3 to situations involving total internal reflection over amended Claim 1.

This unexpected result only occurs over a limited aperture of unusual shape, and is therefore even harder to notice and therefore more unobvious. This issue is discussed in the specification in the paragraph describing Figure 4 of the specification, in the section titled "Operations".

The standard approach to constructing lenses is to use several elements and to coat them with anti-reflecting coatings, sometimes called "multicoatings", in order to reduce light-loss. The fact that it is possible to use a prism to form such an image with zero light loss is an unexpected and potentially commercially important result.

As the examiner correctly points out, Ortobasi in column 6 lines 14-67 teaches, and in fact makes clear that the phenomena of total internal reflection is both well-known and well-exploited in the solar energy collection art, in particular that concerning the Compound Parabolic

Concentrator (CPC), the seminal invention of Roland Winston and the basis for Ortabasi. However, the CPC is in particular not an image-forming mechanism, as is the present invention of Claims 1, 3, 6, 7, 8, 9, 18, 19, and 20 (but not 13, 15, and 17, which are 2-D).

Moreover, Claim 1 as amended and its dependent claim Claim 3 and others specify a particular set of shapes in a specific configuration that produces the surprising and synergistic affect of allowing image formation with zero light loss under some circumstances. This shape and configuration is a necessary condition of that result. The much more general family of "ellipsoidal" shapes taught by Li do not in fact have this surprising property, except in so far as they are close to the shapes recited along with other elements in Claim 1. The invention of Li uses reflection at high angles of incidence (that is, fairly close to perpendicular striking), which preclude the glancing incidence necessary to total internal reflection. This is because in the ellipsoidal and short-focal length case which Li addresses, as opposed to the paraboloidal long focal length case of this application, most of the rays will impinge the surface at an angle of incidence such that total internal reflection is not possible (typically total internal reflection operates only at glancing angles of less than 45 degrees).

Objection #12 also rejects Claims 6 and 17 as obvious given Ortabasi and Li. The applicant agrees multi-cellular planar arrays of light-gathering apparatuses are not novel (see also for example Cobb US 5,056,892 and Magee US 5,644,431, disclosed in the original application), but Claims 6 and 17, and all other claims as amended, are narrowing dependent claims that derive patentability from (amended) independent Claims 1 and 13 in addition to other elements they recite.

### **Summary of response to claim rejections of Objection #12**

In Objection #12, the examiner rejections claims 2, 3, 4, 6, 14, 15 and 17 based on a combination of Li and Ortabasi. The applicant accepts that the (amended) claims 4, 6, 15 and 17, which are narrowing dependent claims of claims 1 and 13 respectively (which are the same as the original 2 and 14), are not novel in themselves, but rather relies upon the patentability of amended Claim 1 and Claim 13 for the patentability of Claims 4, 6, 15, and 17. Claims 2 and 14 are canceled.

Claim 3 is a dependent claim of Claim 1, but furthermore enables a startling result, and is unobvious for that reason as well.

#### **Objection 13 is overcome**

Objection #13 rejects Claim 10 under 35 U.S.C. 103(a) as being unpatentable over Li in view of Hough et al US 6,123,436.

The applicant accepts the lack of novelty of the baffle as described in the specification and relies upon the fact that Claim 10 is a dependent claim of the patentable amended Claim 1 for the patentability of Claim 10.

#### **Objection 14 is overcome**

Objection #14 rejects Claim 11 under 35 U.S.C. 103(a) as being unpatentable over Li in view of Ortabasi and further in view of Hough et al.

The addition of baffles is obvious once one understands that the apparatus of claim 3 can be used as a telescope, and the applicant accepts that baffles add no novelty. Claim 11 as amended is a

dependent claim of (amended) Claim 3, and derives patentability from that claim, in addition to reciting a light baffle.

Moreover, knowledge of Hough does not affect the patentability of Claim 3 (please see below discussion of Hough, Wolter, and Hunter.)

Hough and Ortabasi deal with non-imaging optics, and therefore would not be combined in the field of telescropy. Hunter deals with images in so far as it forms an image of a local power source for the purpose of welding. Wolter does not suggest a split along the optical axis. Li is concerned with power projection and unit magnification, and does not suggest the use of a transparent body. No combination of these sources suggests either Claim 1, 3, or 11. (Please see below discussion under Objection 15 for more explanation.)

### **Objection 15 is overcome**

Objection #15 rejects Claim 12 under 35 U.S.C. 103(a) as being unpatentable over Wolter US 2,759,106 in view of Hough et al US 6,123,436.

It is critical to note that Wolter specifically deals only with reflective surface of complete, 360-degree revolution. The fundamental insight that it is possible to make a split along the optical access and use 180-degree surfaces thus allowing the electromagnetic rays room to remain completely within a transparent medium as claimed in amended Claim 1 is not suggested by Wolter.

Note that in Fig. 1B, 2b, and 2c and Fig. 4 of Wolter it is clear that each



surface is a complete revolution. Since Wolter does not imagine the use of internal reflection from an optically dense medium as claimed in the independent Claim 1 (as amended), and Wolter imagines using only glancing rays, that patent does not confront or solve the fundamental problem solved by Claim 1 (as amended) which is that by using 180-degree surfaces of revolution the electromagnetic rays can be kept entirely within the transparent medium and still strike the ocular surface without interference from another surface.

Hough similarly does not solve, address, or suggest this problem, using only complete surfaces of revolution. Moreover, Hough is a non-imaging technology, which does not preserve images.

The applicant agrees that the addition of baffles do not add to the patentability of Claim 12, but rely upon the patentability of Claim 1 (as amended) to obtain the patentability of Claim 12. Beyond the element of light baffles, Hough, Wolter and Hunter add nothing that affects the obviousness of the amended Claim 1, as discussed above.

### **On the word "Optics"**

The applicant has removed the word "optical" from the amended Claim 1 in order to address the Claim Objection #2 of the Office Action. The word "optic" and its related adjectives and adverbs "optical" and "optically" etc. are used commonly used both to mean the band of electromagnetic radiation to which the human eye is sensitive, in addition to a second sense of the reflective, refractive, and diffractive manipulation of radiation of any frequency. For example, Wolter using the term "optical apparatus" in his main claim, although in fact it is an X-ray apparatus. Therefore, this amendment does not significantly

change Claim 1 as amended.

This interpretation is supported in the specification in the third-to-last paragraph of the specification.

More generally, a standard textbook on optics, entitled Optics, by Hecht and Zajac, treats a wide range of electromagnetic frequencies. Also, the Dictionary of Mathematics, edited by John Daintith and R. D. Nelson defines "optical property" as "the focal property of a conic, see also ellipse, hyperbola, and parabola", thus presumably giving the term an abstract mathematic meaning irrespective of electromagnetic frequency ranges. Thus the term "optical axis" of the parabola is retained in the claim as the clearest expression of the invention, since the term has a mathematical definition independent of physics.

### **Request for Reconsideration**

Based on all of the above amendments and explanations, the applicant submits that the specification and claims are now in proper form and that all claims define patentably over prior art. Therefore the applicant submits that this application is now in condition for allowance, which action he respectfully requests.

Moreover, the applicant requests full consideration of those claims that were not fully considered in the office action due to problems in their form, those being the amended Claims 7-9 and 18-20.

### **Conditional Request For Constructive Assistance**

The applicant has amended the claims of this application so that they are proper, definite, and define novel structure which is also unobvious. If, for any reason this application is not believed to be in full condition for allowance, applicant respectfully requests the constructive assistance and suggestions of the Examiner in order that the undersigned can place this application in allowable condition as soon as possible and without need for further proceedings.

Respectfully,

*Robert L. Read, 4/12/2005*

Robert L. Read, PhD

1709 Norris Dr.

Austin, TX, 78704